

# Systematic study of DOM response using ROMEO and DOMINANT

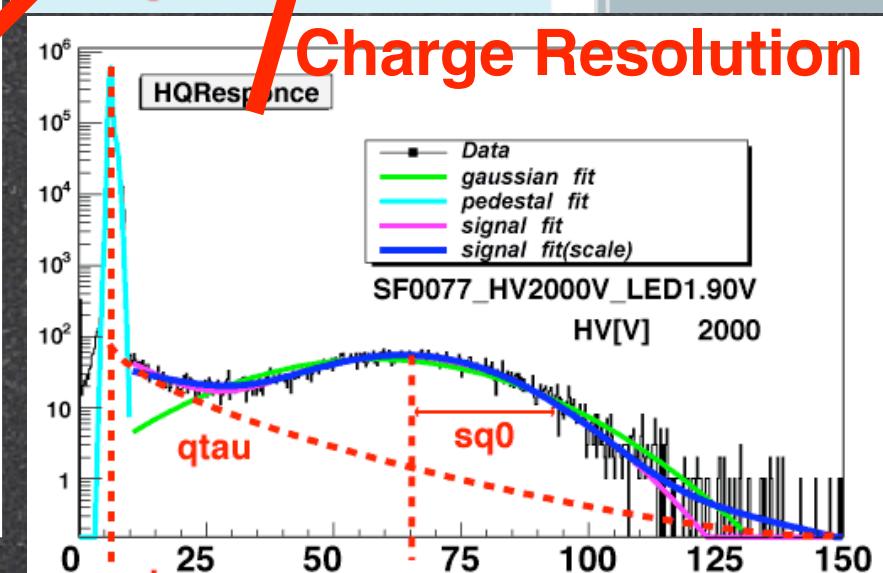
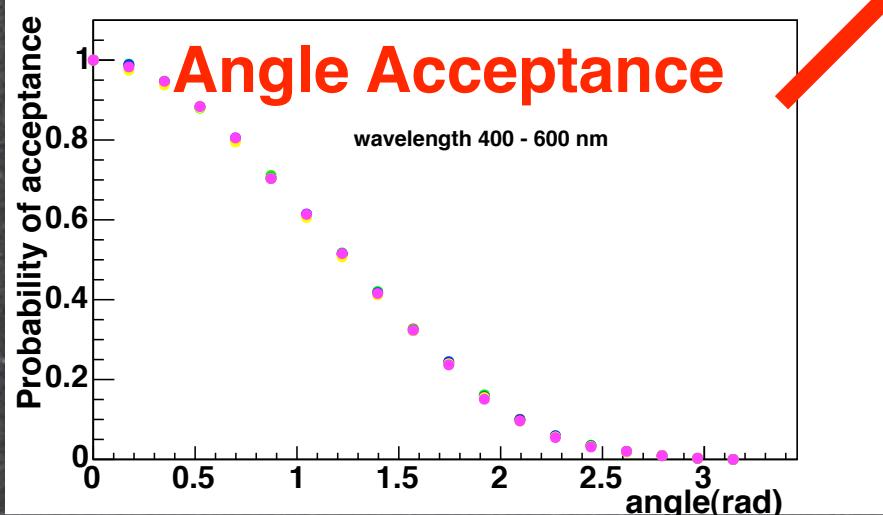
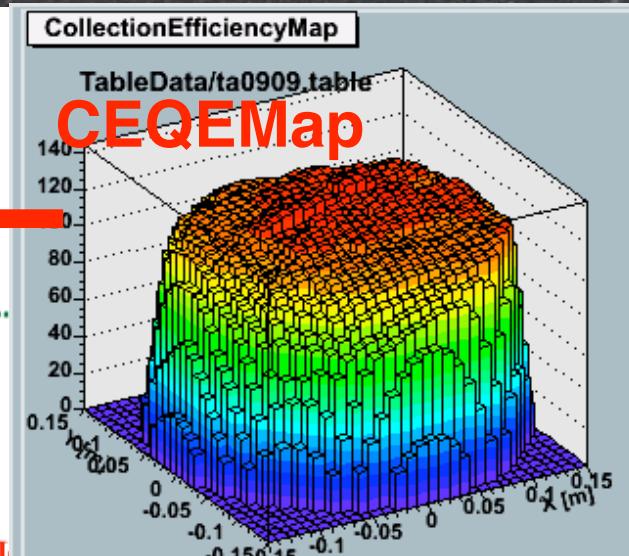
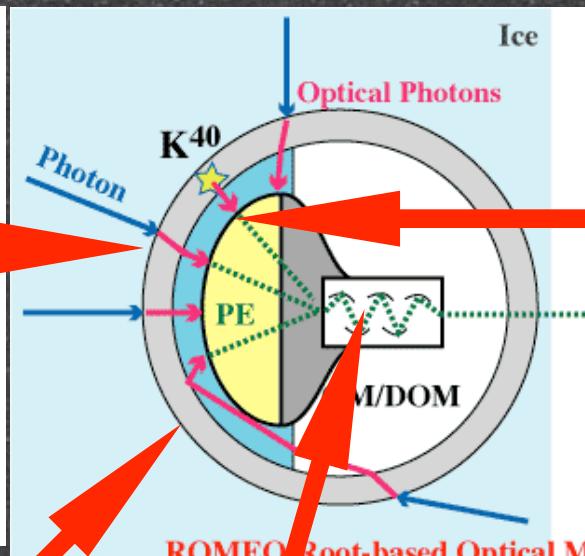
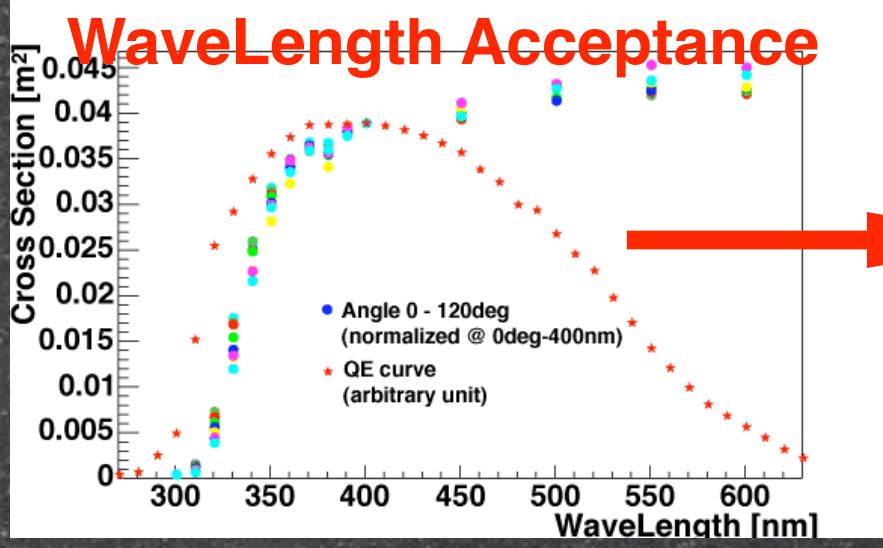
IceCube Collaboration Meeting in Berkeley

Mar. 20, 2005

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Chiba University

- Simulation procedures ~ ROMEO meets JULIeT!
- ROMEO ~ Root based OM EmuratOr
- JULIeT ~ Java based Ultra-high energy Lepton Integral transporter
- Summary

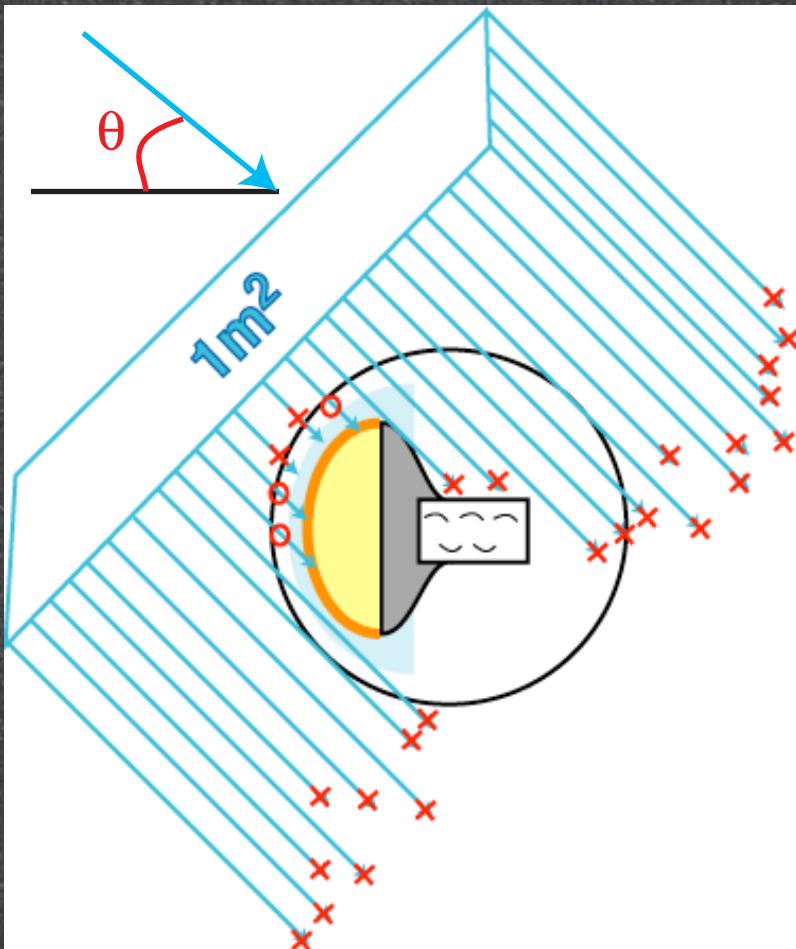
# Simulation parameters of ROMEO



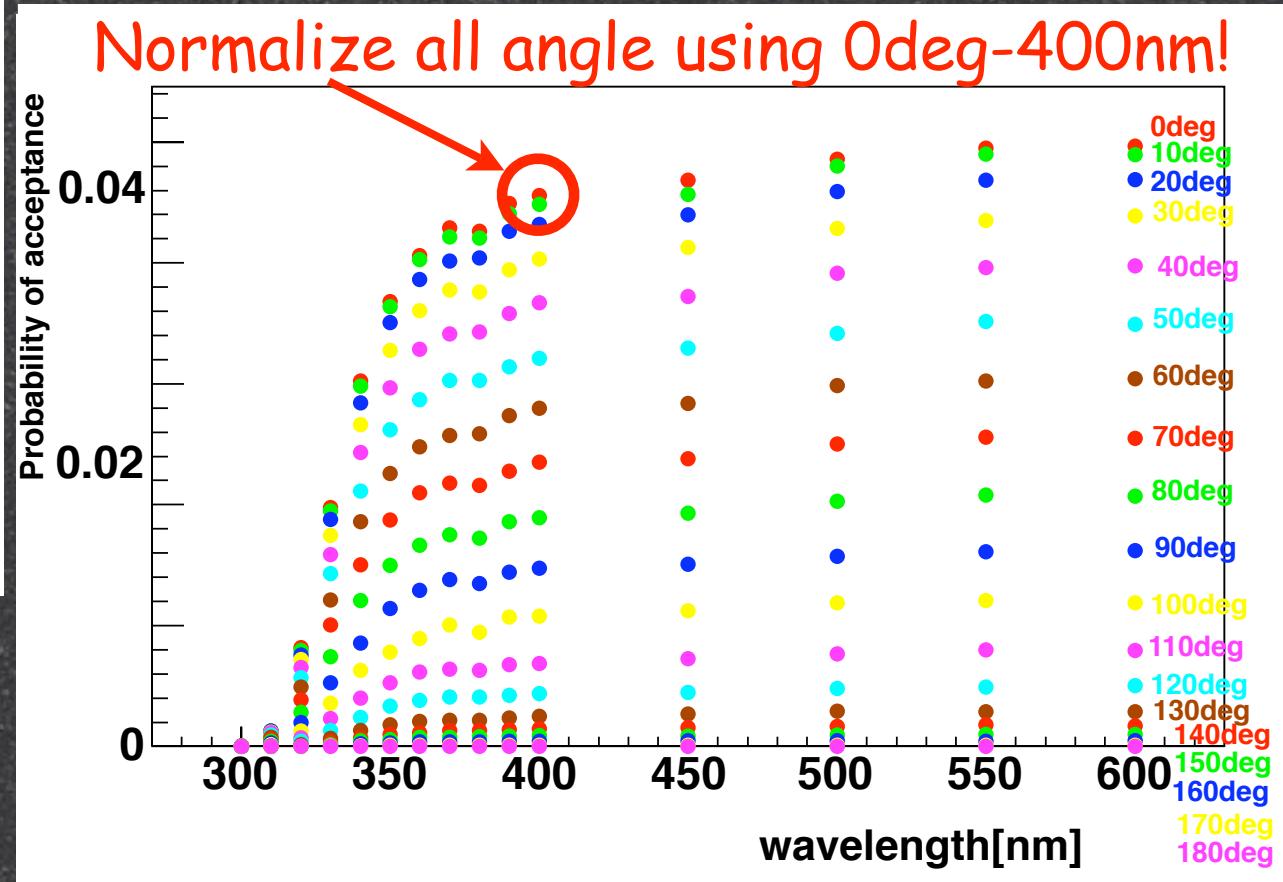
$$f = \frac{P_{\text{ex}}}{q\tau} \exp\left(-\frac{q - q_{\text{ped}}}{q\tau}\right) + (1 - P_{\text{ex}}) \frac{1}{\sqrt{2\pi} s\tau N} \exp\left(-\frac{(q - (q_0 + q_{\text{ped}}))^2}{2 s\tau^2}\right)$$

# Photon Angle Acceptance of DOM

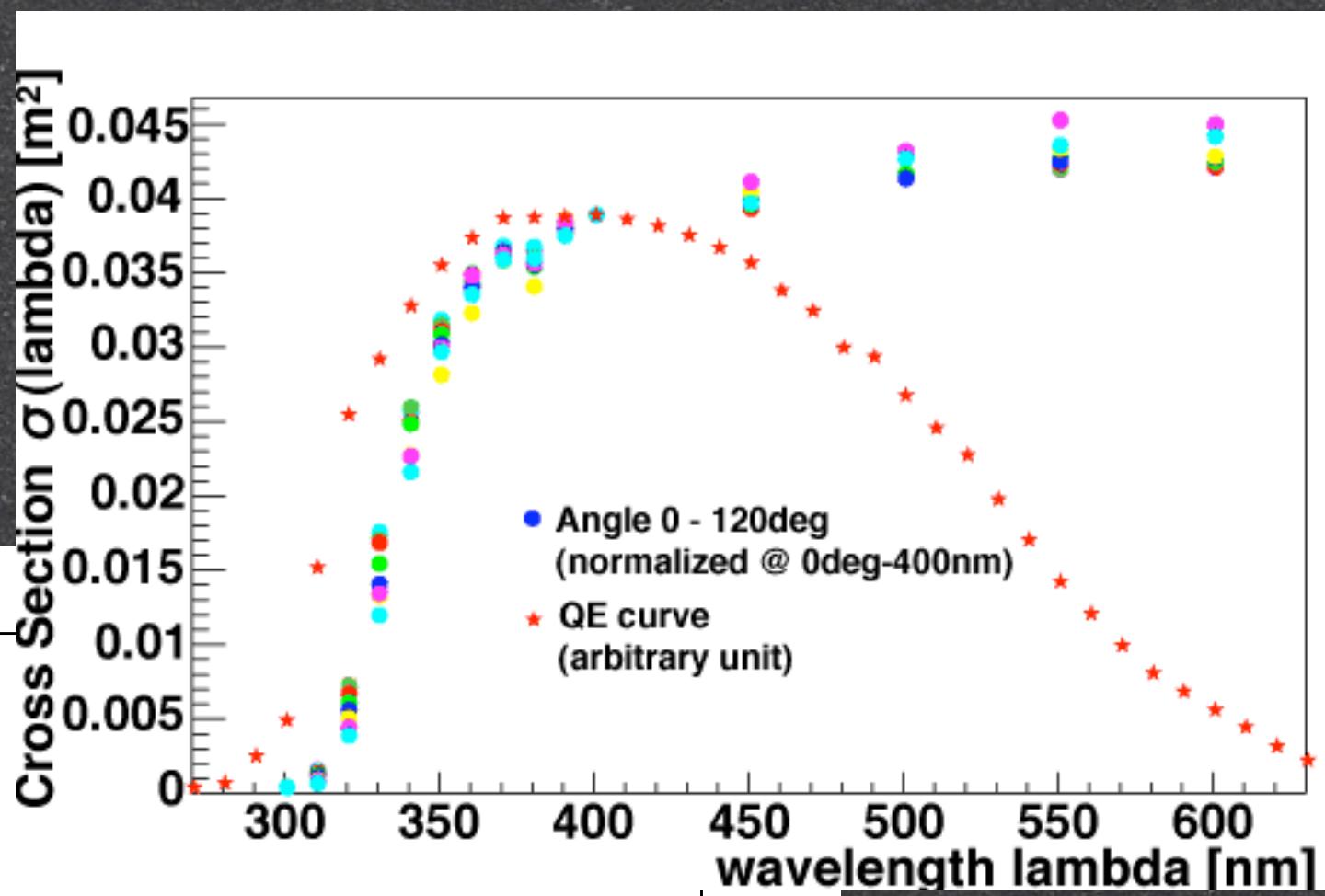
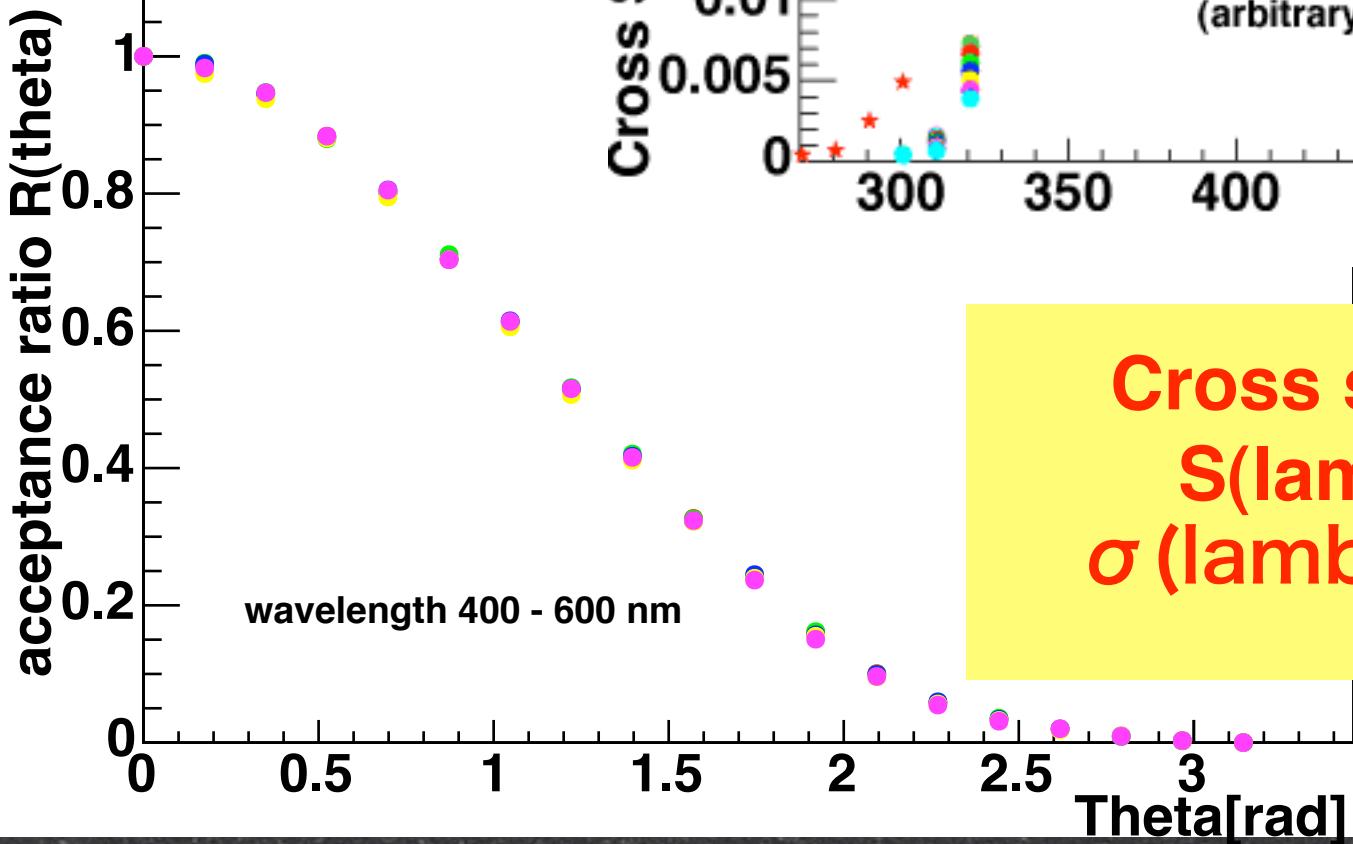
(calculated by DOMINANT)



Inject parallel photon beam with angle theta from  $1\text{m}^2$  source area  
Count survived photons at Photo Cathode



# Photon Acceptance of DOM



Cross section of DOM  
 $S(\lambda, \theta) = \sigma(\lambda) \cdot R(\theta)$

# Angle Acceptance of DOM

# of photons / event :  
~ 10000 (deviate with  $\sqrt{10000}$ )

# of events:

1000

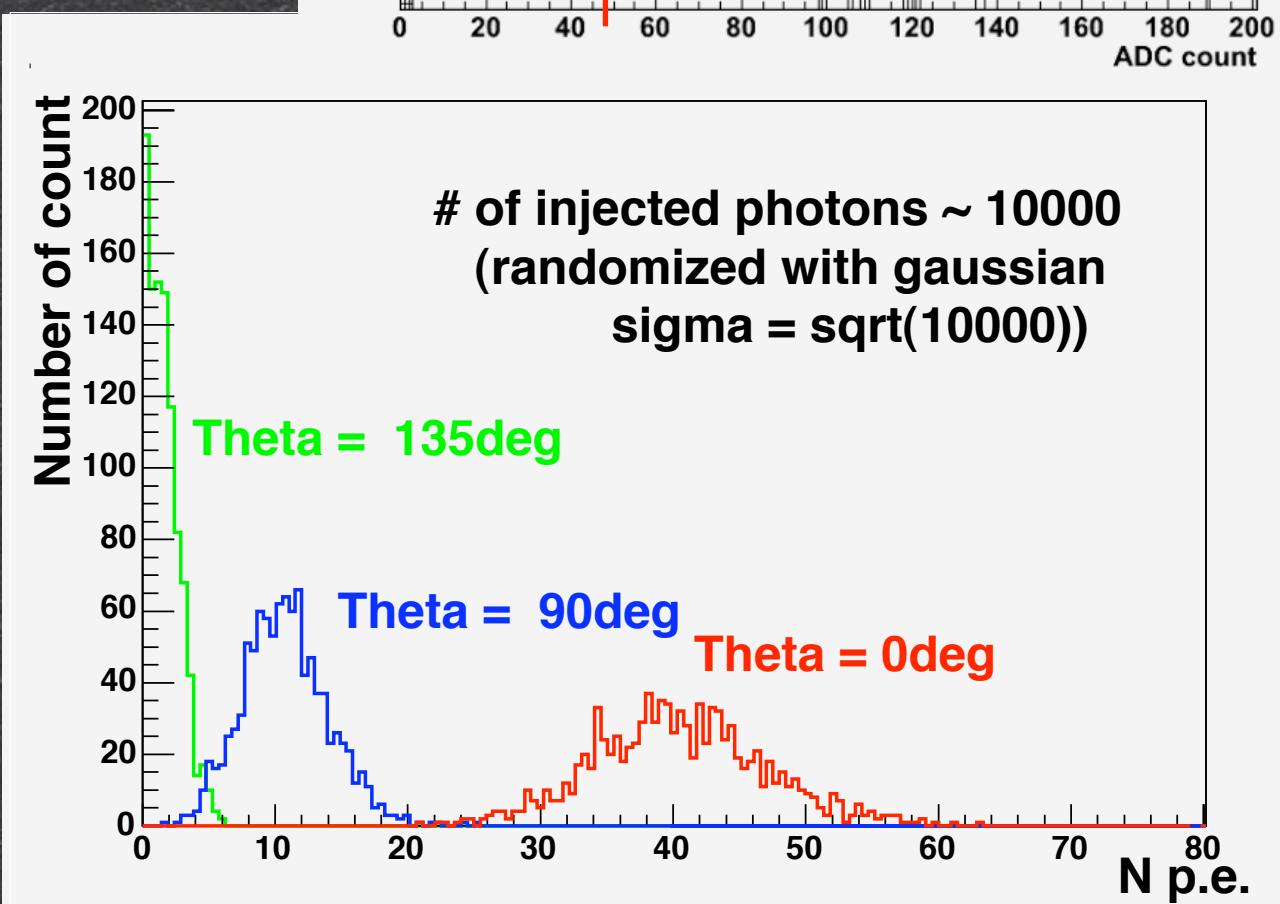
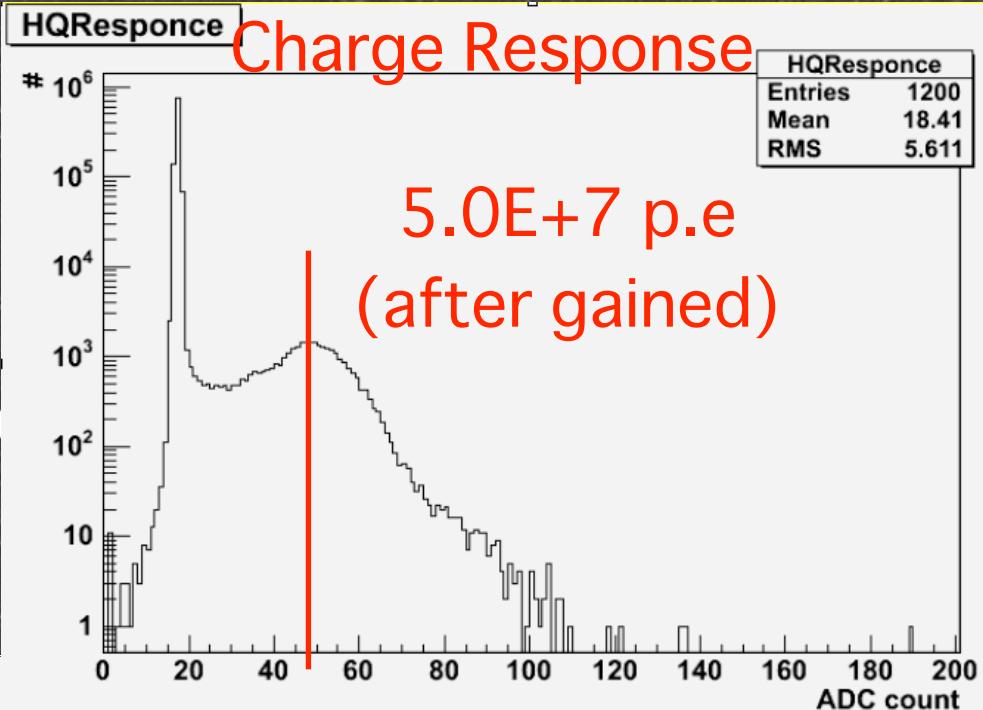
WaveLength:

Cherenkov spectrum

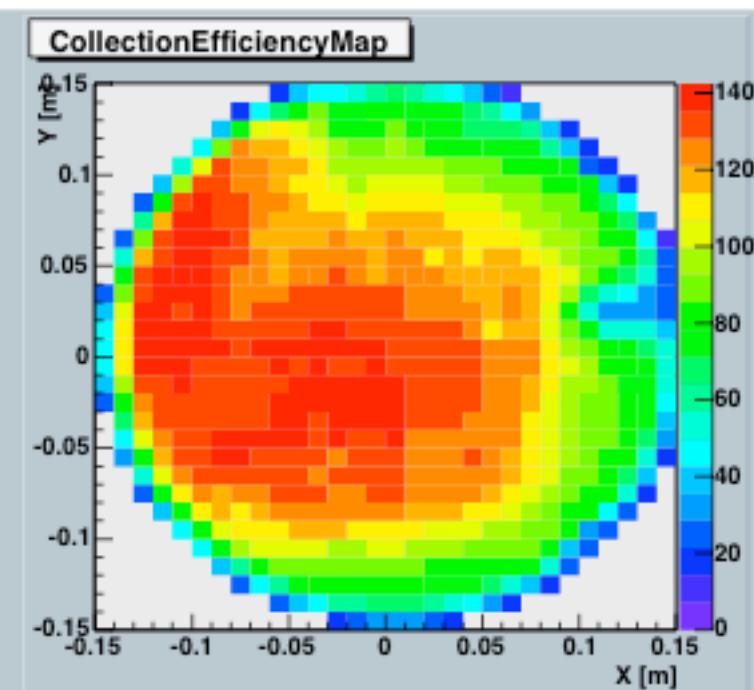
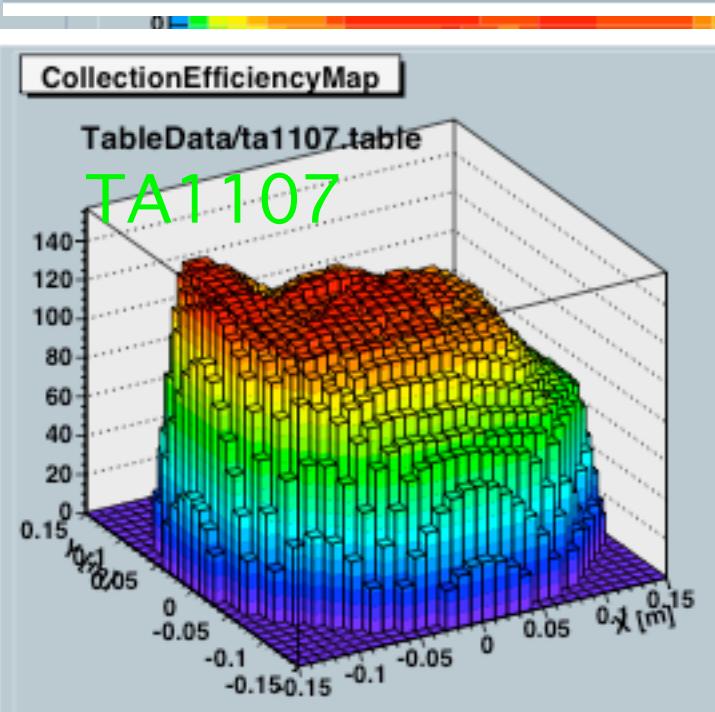
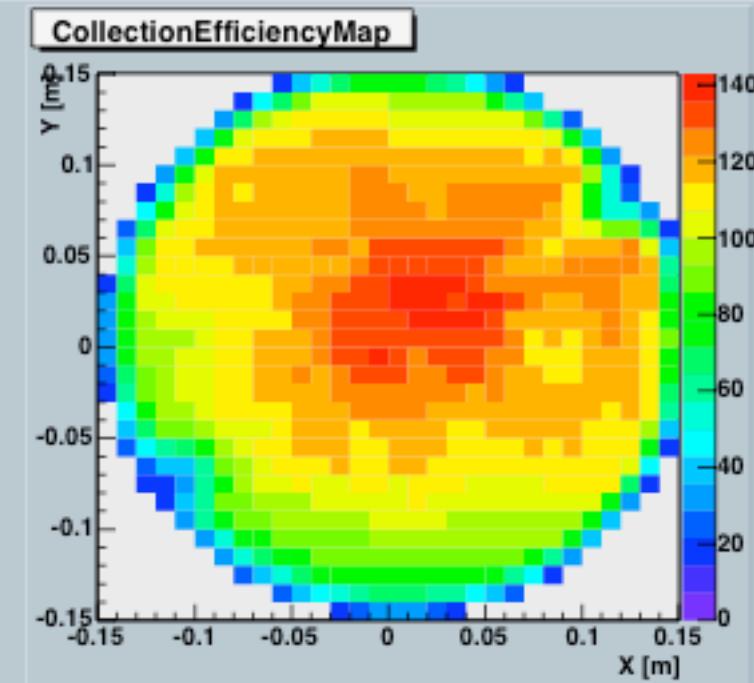
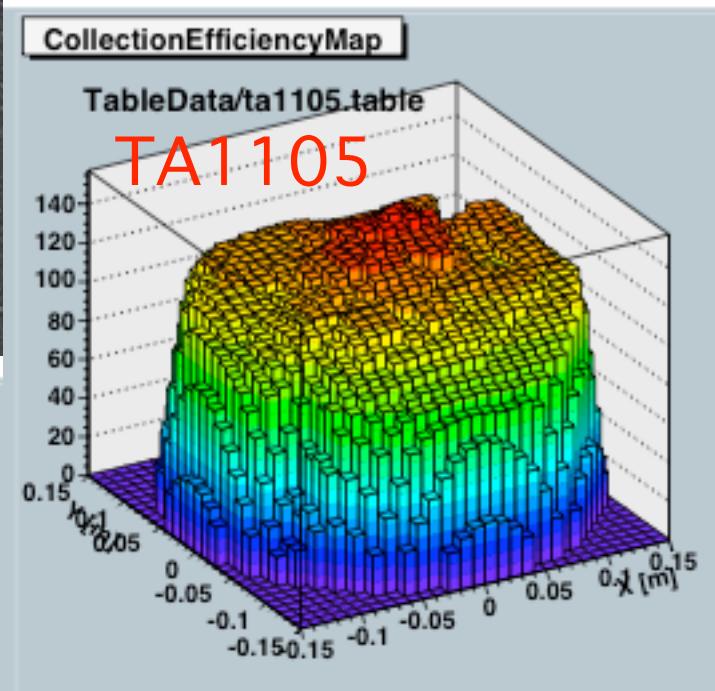
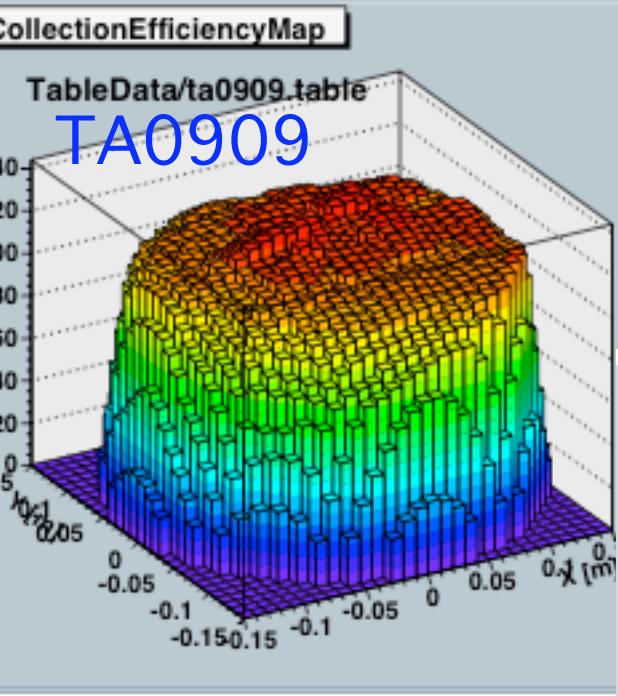
$$N_{p.e.} =$$

Sum up charge

$$\frac{5.0E+7 * 1.6E-19}{}$$

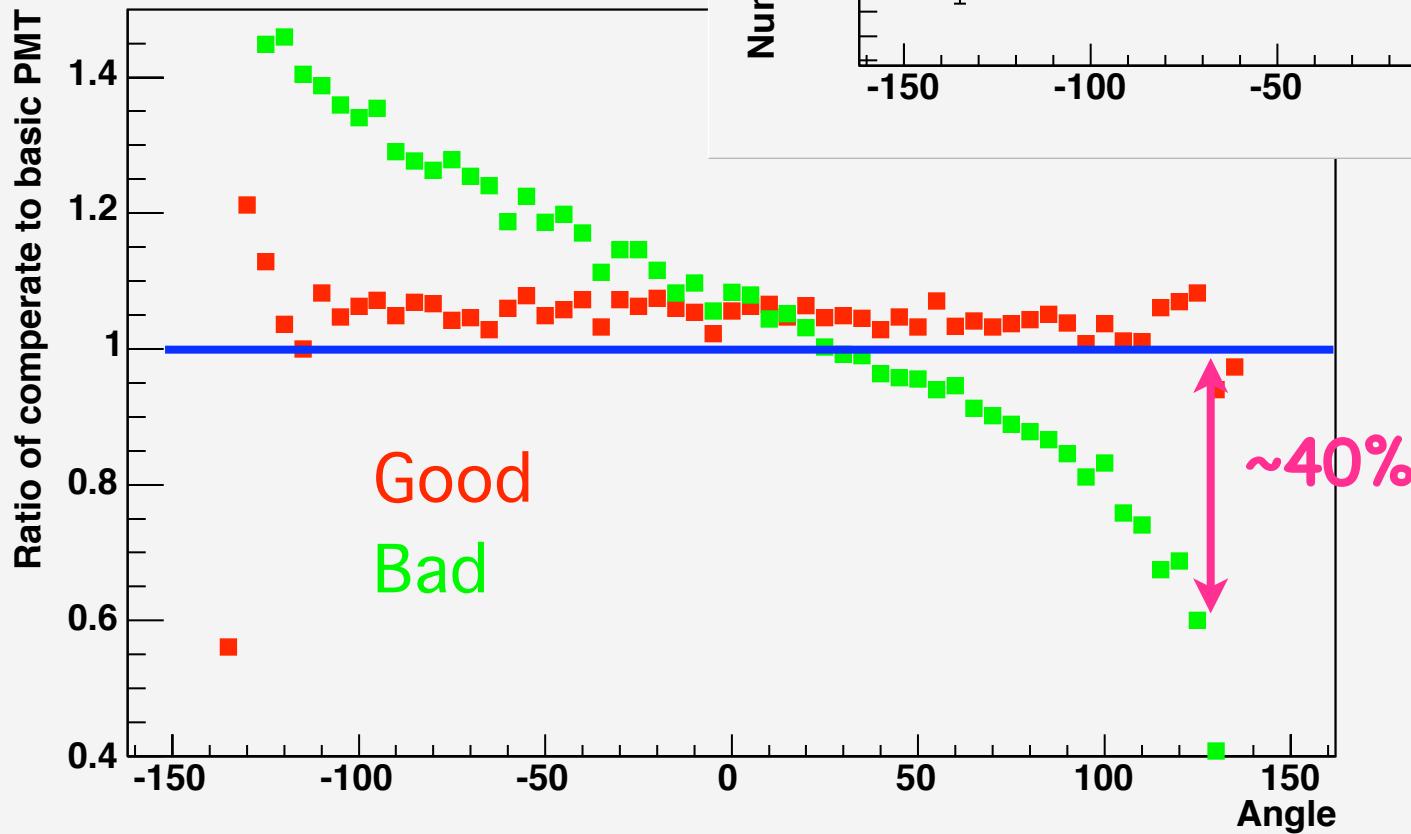


# QE maps of PMTs

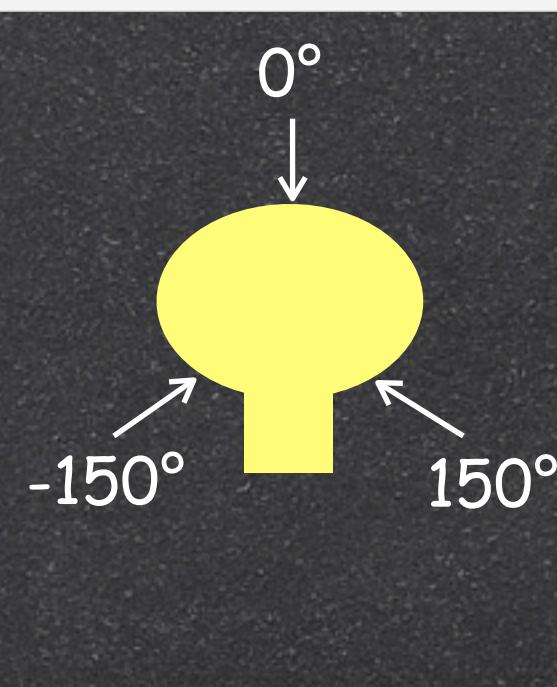
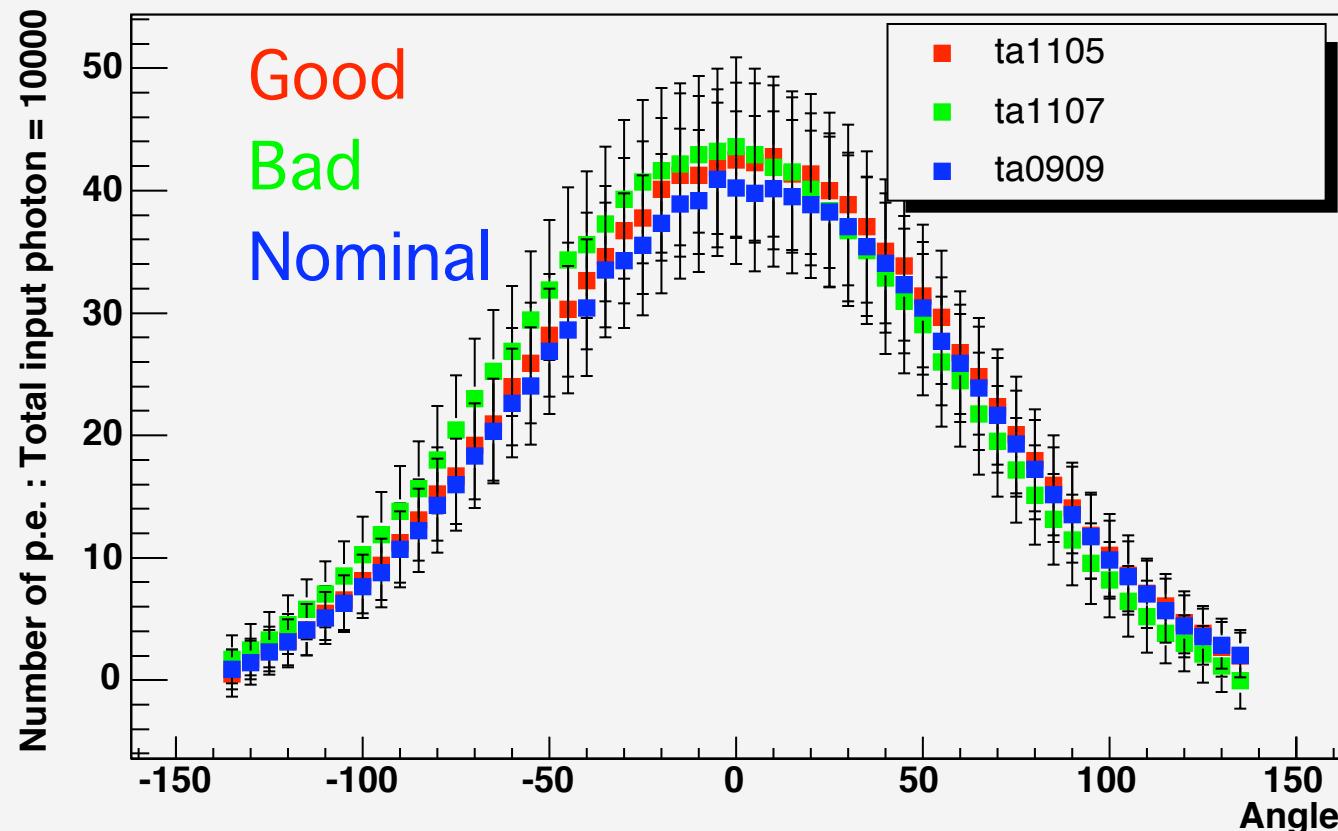


# Angle acceptance of PMTs Cherenkov spectrum

Graph

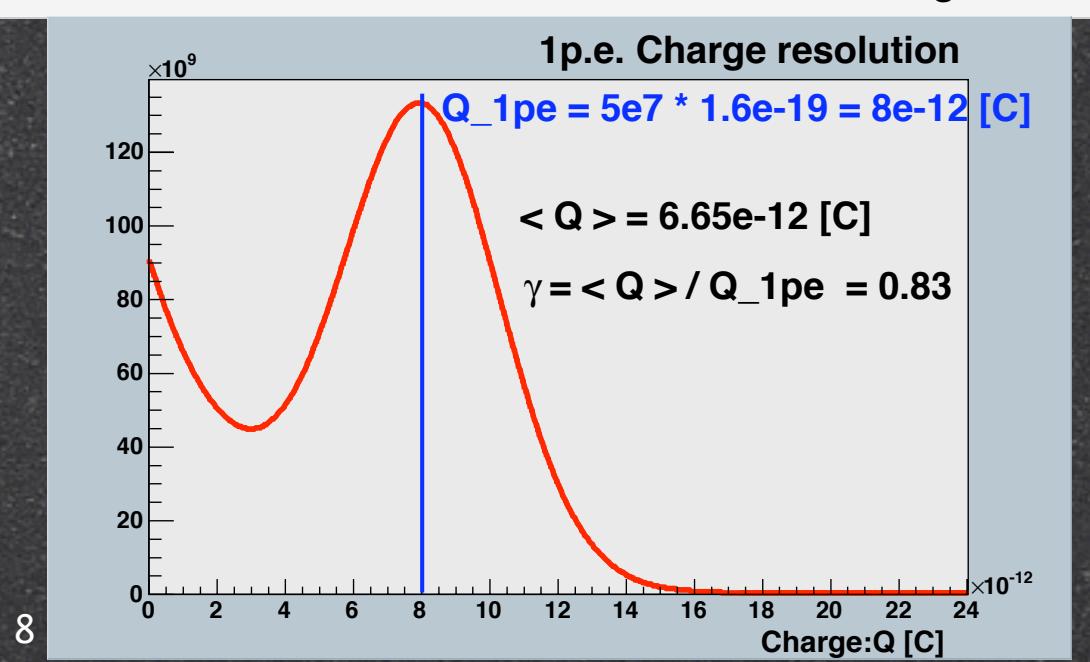
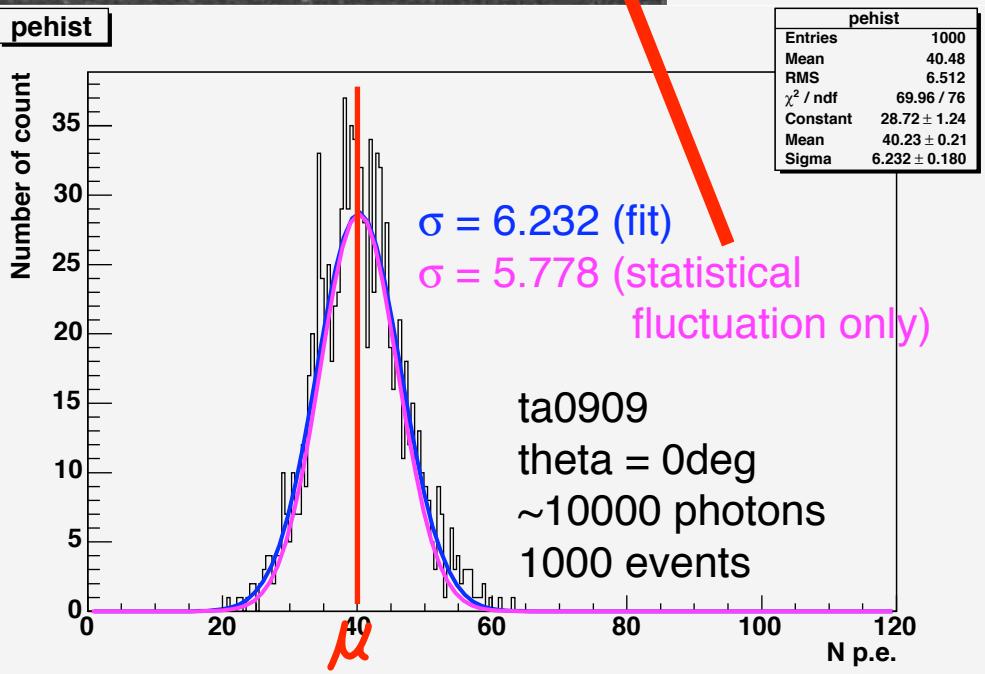
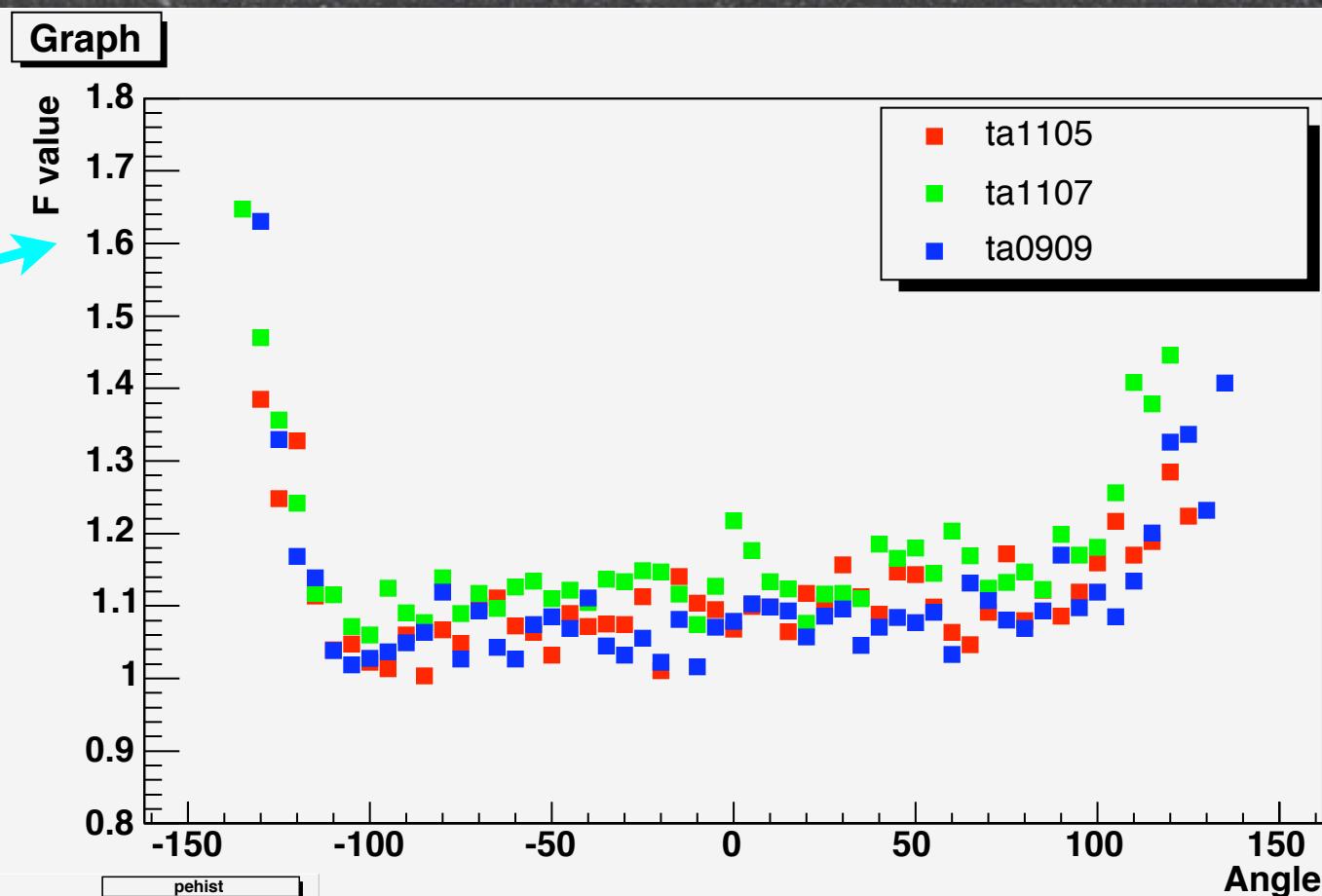


Graph

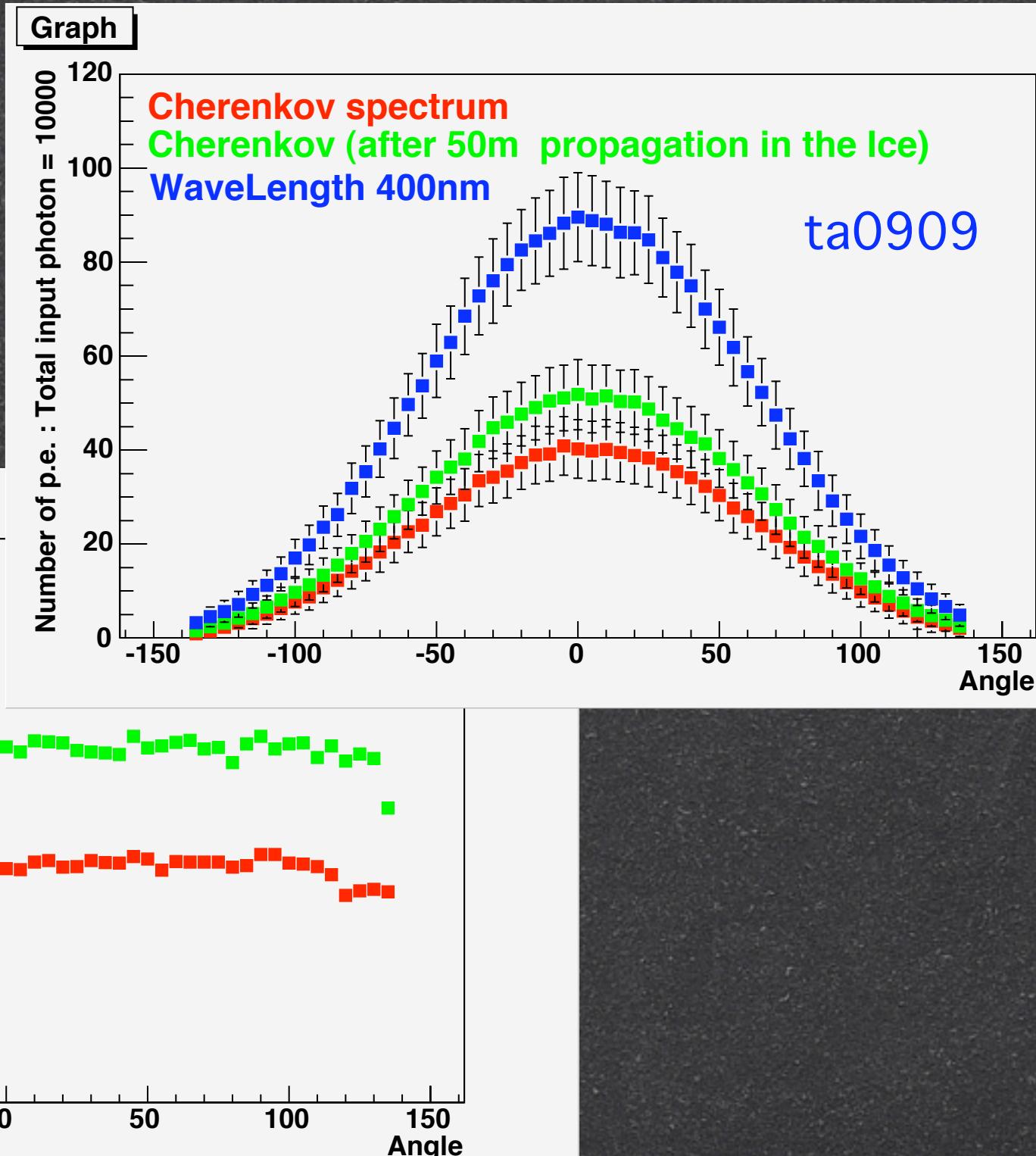


# Deviation from statistic

$$\frac{\sigma}{\mu} = \boxed{F} \cdot \frac{1}{\sqrt{\mu/\gamma}}$$



# Wavelength dependence of Angle Acceptance



# Summary

- Using "ROMEO" , "DOMINANT" and our calibration results, we estimated tube-to-tube statistical errors.
- The most sensitive parameter to the efficiency is the injection angle. Tube-to-tube differences could be over 40% at theta =  $\pm 135$  degree.
- Wavelength dependence caused by different propagation length appears as scaling factor at least distance < 50m.